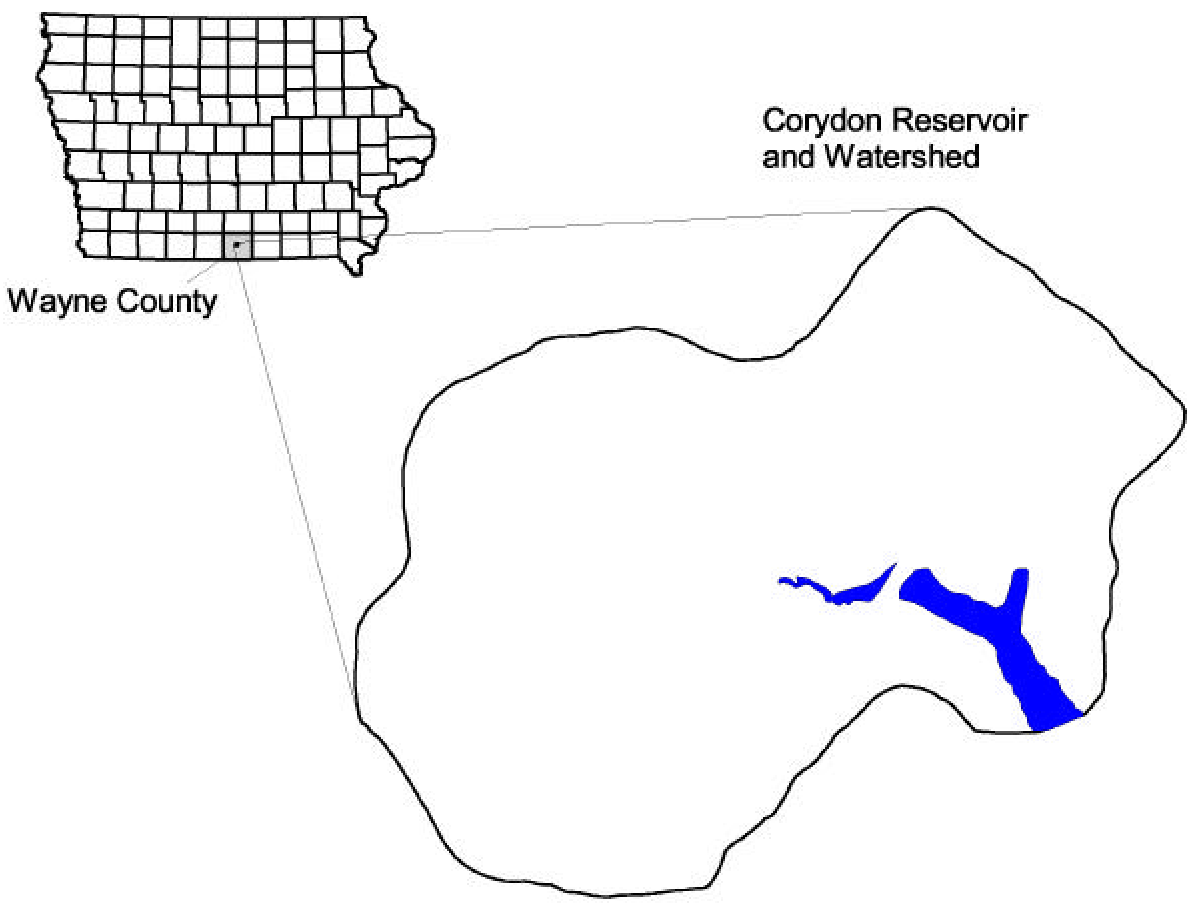
Total Maximum Daily Load
For Atrazine
Corydon Reservoir
Wayne County, Iowa

November 7, 2000

Iowa Department of Natural Resources
Water Resources Section

Corydon Reservoir
Wayne County, Iowa

Waterbody Name:	Corydon Reservoir
IDNR Waterbody ID:	IA 05-CHA-00620-L
Hydrologic Unit Code:	HUC11 10280201010
Location:	Sec. 24, T69N, R22W
Latitude:	40 Deg. 45 Min. N
Longitude:	93 Deg. 20 Min W
Use Designation Class:	A (primary contact recreation) B(LW) (aquatic life) C (potable water source)
Watershed Area:	1,680 acres
Lake Area:	58 acres
Major River Basin:	Upper Chariton
Tributaries:	Unnamed intermittent streams
Receiving Water Body:	West Jackson Creek
Pollutant:	Atrazine
Pollutant Sources:	Agricultural Non Point Sources
1998 303d Priority:	Low



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1. Description of Waterbody and Watershed

Corydon Reservoir was constructed in 1919 and is located in south central Iowa on the west edge of Corydon, Iowa. The reservoir is an on-stream impoundment on a tributary of West Jackson Creek. The reservoir has a surface area of 58 acres when completely full and is split into two sections by railroad tracks. The main area of the reservoir is 52 acres, and the remaining 6 acres are a shallow marsh like area. The mean depth of the reservoir is approximately 5.9 feet and the volume is almost 15 million cubic feet when full.

Corydon Reservoir is located within the Corydon Lake Park (approx. 160 acres), managed by the Wayne County Conservation Board. The park and reservoir are used primarily for camping, fishing, boating, picnicking and hiking.

The reservoir is designated in the Iowa Water Quality Standards for Class “A, B(LW), and C” beneficial uses. Waters that are designated as Class "A" are to be protected for primary contact recreation (for example, swimming and water skiing). Waters designated for Class "B(LW)" (lakes and wetlands) are protected for wildlife, fish, aquatic and semi-aquatic life and secondary contact water uses. Rivers or lakes designated as Class "C” are protected as a raw water source of potable water, suitable for a drinking water supply. The reservoir was used as a potable water source from 1919 to 1993. The City of Corydon no longer uses the reservoir as their water supply, but the drinking water standard must still be met because the Class “C” use was an existing use on or after November 25, 1975, as defined in 40 CFR Part 131.3(e).

The Corydon Reservoir is in the South Fork Chariton River Watershed, HUC 11: 10280201010. The soils in the Corydon Reservoir watershed are silty, clay loams that drain water poorly. The reservoir watershed is mainly row crop (52%) with about 335 acres of corn and about 540 acres of soybeans. The remaining area (805 acres) of the watershed is pasture and hayland (40%), woodlands (4%) and other (4%) (Sitzmann, 2000).

2. Applicable Water Quality Standards

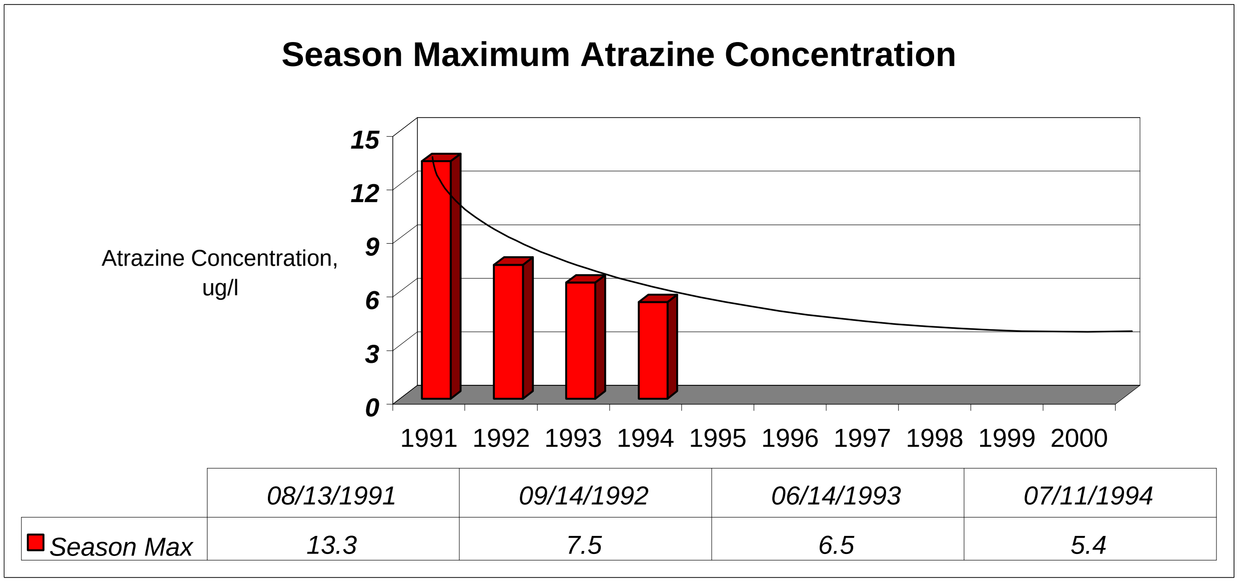
Corydon Reservoir was assessed in the Iowa Department of Natural Resources (IDNR) 305(b) database as not supporting its drinking water designated uses due to elevated levels of atrazine. The IDNR listed Corydon Reservoir on the 1998 303(d) list of impaired waters for atrazine. This listing was based on a study done by the United States Geological Survey (USGS) on Corydon Reservoir in the early 1990s (USGS, 1993). Iowa’s water quality standard for atrazine is noted as an acute value of 3 ìg/l for the class “C” drinking water use. However, the numerical value reflects the EPAs Maximum Contaminant Level (MCL) criterion. Proposed Water Quality Standard rule changes will reference the value as an MCL.

3. Water Quality Conditions

USGS monitored the reservoir from 1990-94 at several sampling points in the reservoir. It was found that during June through September 1991, the average concentration of atrazine was 8ìg/l. The observed seasonal, June- September, maximum in lake concentrations were plotted and used to predict the 1999 seasonal maximum concentration, see figure 1.

Since the USGS study in the early 1990’s, approximately 50,000 feet of terraces have been constructed within the watershed (Sitzmann, 2000). The improvements made to this watershed in the early 1990's were part of a demonstration project. This project involved various local, state and federal agencies, and most importantly local citizens. The fields of row crops in the watershed have grass waterways that filter overland runoff prior to it entering the streams that flow into the reservoir. The landowners are applying less atrazine to their fields, and some landowners practice no till on their fields (EPA, 3/2000).

Figure 1. Observed seasonal maximum values extrapolated to 2000 to predict 1999 seasonal maximum value.



The Natural Resource Conservation Service has designated the majority of the land within the watershed as Highly Erodible Land (HEL). Several of the farmers have installed drainage tile systems. At least one tile outlet is discharged into a wetland, the remaining tile outlets discharge directly into the streams that feed Corydon Reservoir. In a majority of the fields a small buffer strip is left along the streams.

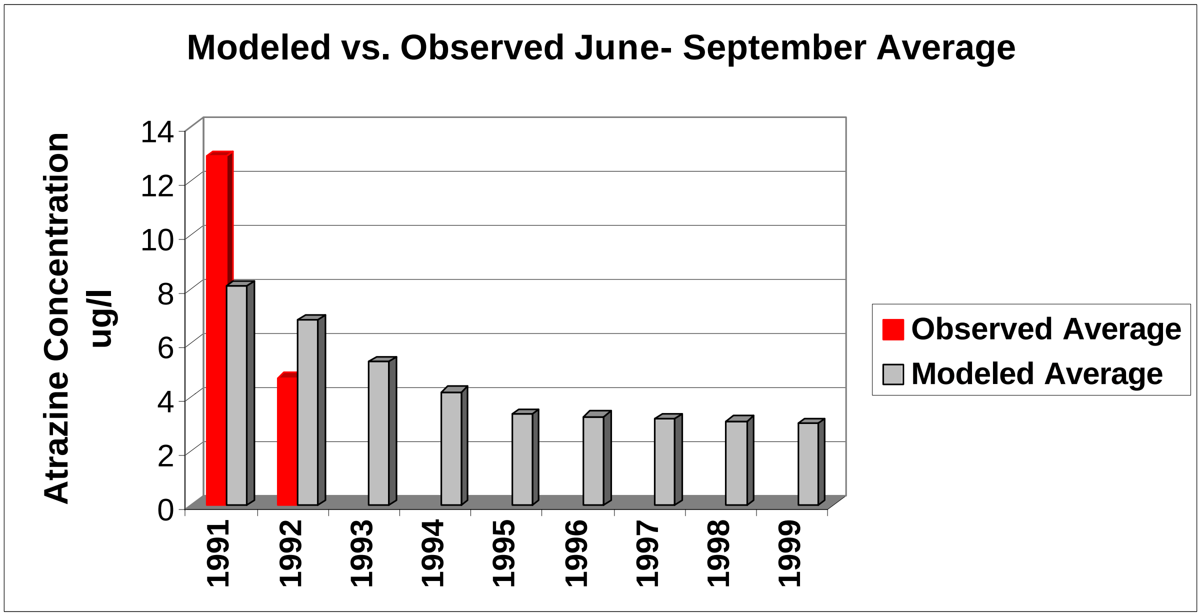
The watershed was modeled using EPA's Screening Procedures to predict the current concentrations of dissolved atrazine in the reservoir (EPA, 1985). The screening procedure uses the Universal Soil Loss Equation, the Soil Conservation Service's Curve Number equation and a first-order decay rate equation for pesticides to determine the amount of pesticide in the runoff that enters the waterbody. From this information the in-lake concentrations can be calculated (see Appendix I for model input). The model was calibrated using the USGS study from 1990-94. The observed seasonal average values were plotted along with the modeled seasonal averages for 1991-1999, see figure 2. The modeled values correlate with the extrapolated seasonal maximum values to indicate the modeled predictions are reasonable.

Based on the implementation of best management practices (BMPs) in the watershed and current atrazine application rates, the average modeled atrazine concentration for June through September, 1999 is 3.04 ìg/l (Sitzmann 1996 & 2000). Because the model uses conservative assumptions and without having exact atrazine application rates and dates, the waterbody may be meeting Water Quality Standards (WQS); but the decision of impairment needs to be based on monitored results rather than modeled. This TMDL will therefore, employ a phased approach. An "up front" monitoring plan will be established for the reservoir, and monitoring data collected.

4. Desired Endpoint

The desired endpoint is to reduce atrazine levels below the water quality criterion of 3 ìg/l.

Figure 2. Modeled seasonal averages predict the 1999 average to be 3.04 ìg/l.



5. Source Assessment

The source of atrazine is from agricultural runoff in the watershed. The Corydon Reservoir watershed is 52% row crop with about 335 acres of corn and about 540 acres of soybeans. The remaining 805 acres of the watershed is pasture and hayland (43%) and woodlands (4%) (Sitzmann, 2000). Atrazine is typically applied to cornfields pre-emergent, but can be applied post-emergent. Corn is generally planted the end of April through mid-May, depending on the weather conditions (EPA, 2000). The input parameters that change from year to year are the acres of corn, the SCS Curve number (which indicates landuse practices) and atrazine application amounts in grams/hectare (Table 1).

Table 1. Model input values for 1991-1999. Values are based on implementation of Best Management Practices.

Year		1991	1992	1993	1994	1995	1996	1997	1998	1999
Corn Acres		400	392	384	376	368	360	352	344	335
SCS Curve #		90	89	87	85	83	83	83	83	83
Amount of Atrazine Applied	g/ha	4484	3756	3027	2298	1570	1514	1457	1400	1345
	lbs/ac	4.00	3.35	2.70	2.05	1.40	1.35	1.30	1.25	1.20

6. Load Capacity

The Load Capacity is the amount of pollutant a waterbody can receive and still meet Water Quality Standards. The load capacity is being expressed as pounds per year because springtime field application of atrazine is released to the environment through multiple rainfall events occurring over extended periods of time. Further, the reservoir will dilute these runoff events with the available water stored in the reservoir. The load capacity was modeled using a spreadsheet which considered yearly application of atrazine and subsequent loading into Corydon Reservoir. Input to the spreadsheet included rainfall, runoff, soil transport, and atrazine field application rates. These results were show on Figure 1, which demonstrates that the Iowa Water Quality Standard of 3 micrograms/liter for atrazine will be achieved. The load capacity was calculated to be 2.70 pounds of atrazine delivered to Corydon Reservoir. The model considered a seasonal average volume of the reservoir of 332 acre-feet, and assumed it was full in June, 98% full in July, 95% full in August and 92% full in September.

7. Pollutant Allocation

7.1 Waste Load Allocation

Since there are no point source contributions of atrazine in the watershed the Waste Load Allocation will be zero.

7.2 Load Allocation

The Load Allocation is the total load to the lake during the year from nonpoint sources. The current loading to the reservoir is estimated to be 2.74 pounds of atrazine per year. The Load Capacity of the reservoir is 2.70 pounds of atrazine per year. Accounting for the Margin of Safety (10% = 0.27 pounds per year), the Load Allocation is 2.43 pounds of atrazine per year. Based on the conservative nature of the model, the impairment needs to be further defined through monitoring. Therefore, this TMDL will use a phased approach, and implement an “up front” monitoring program. The Corydon Reservoir water quality will be reassessed after a minimum of two years of data collection. If the reservoir is not meeting Water Quality Standards for atrazine, then more BMPs may need to be implemented throughout the watershed.

7.3 Margin of Safety

This TMDL for atrazine has both an explicit and implicit margin of safety. The explicit margin of safety is 10% of the Load Capacity, which is 0.27 pounds of atrazine per year. An implicit margin of safety is incorporated in the sediment delivery calculations in Section 3. The Universal Soil Loss Equation (USLE) does not use the modern databases and more current research associated with the Revised Universal Soil Loss Equation (RUSLE). Therefore, the sediment delivery and resultant atrazine delivery predictions from the USLE may be greater than what might be expected with RUSLE. These assumptions also contribute to the final margin of safety, so the margin of safety is slightly more then 0.27 pounds of atrazine per year.

8. Monitoring

Corydon Reservoir will be monitored for atrazine for 2-3 years to determine the current condition of water quality. The reservoir will be assessed at least monthly during spring and fall, and weekly during the period of atrazine application. It is necessary to monitor more frequently during this time since atrazine is typically applied pre-emergent. Also there is a greater chance of runoff due to the increase in precipitation. This monitoring effort needs to follow the state’s approved Quality Management Plan. If the watershed group implements this water quality monitoring plan, the approved monitoring plan needs to include a provision for the raw data to be submitted to the State for their review.

9. Implementation

The Rathbun Land and Water Alliance (RLWA), has developed a plan to improve water quality in Corydon Reservoir, since it is in the upper reaches of the Rathbun Reservoir Watershed. Members of RLWA include Rathbun Regional Water Association, Wayne County Soil and Water Conservation District, landowners, the Natural Resource Conservation Service, and USGS. This plan includes monitoring and installation of BMPs. The RLWA will begin monitoring the lake prior to any land application of herbicides in 2000. The monitoring will continue for 2-3 years. After the monitoring program the State will determine the level of impairment and the Alliance will determine if additional BMPs are necessary.

In the interim, the watershed group has applied for grant funds from Clean Water Act Section 319 and Division of Soil Conservation to fund additional BMPs. These BMPs should have the effect of reducing sediment and atrazine delivery to the lake. The Novartis company has offered to analyze samples taken by the group for the atrazine concentration. Novartis will submit to the Iowa DNR a QA/QC plan in support of this monitoring and analysis.

An alternate model scenario was run assuming 50% of the corn crop was planted in the terraced fields each year. This scenario predicted in lake-atrazine concentrations to be lower than the 1999 run prediction. Planning crop rotation to insure a portion of the corn crop is planted in the terraced fields will likely reduce the atrazine loading to the reservoir. Another suggested BMP that could be implemented, while the monitoring is being conducted, is to increase buffer strip area. Buffer strips may improve all aspects of water quality in Corydon Reservoir, by filtering out sediment, atrazine, nutrients and other agricultural chemicals.

10. Public Participation

Public meetings were held March 9, 2000, and September 21, 2000 at the community building in Corydon to discuss the aspects of the Corydon Reservoir TMDL.

11. References

Chapra, Steven C. 1997. Surface Water-Quality Modeling

EPA. 1985. Water Quality Assessment: A screen procedure for toxic and conventional pollutants in surface and ground water- Parts I & II: EPA 600/6-85/002a &b.

EPA. March 9, 2000. Conversation among EPA technical staff and members of the Rathbun Land and Water Alliance.

EPA. April 19, 2000. Comments received at the Technical meeting in Des Moines

*Foster, George R. (Editor). 1977. Soil Erosion: Prediction and Control

*Grover, Raj and Allan J. Cessna. 1988. Environmental Chemistry of Herbicides, Volume II.

*Haith, Douglas A., et al. February 1981. Watershed Loading Functions for Nonpoint Sources; Journal of the Environmental Engineering Division

Kalkhoff, Stephen J. 1993. Water Quality of Corydon Reservoir Before Implementation of Agricultural Best-Management Practices in the Basin, Wayne County, Iowa, September 1990 to September 1991; USGS report 93-4099.

Rathbun Land and Water Alliance. No date: Rathbun Land and Water Alliance- Strategic Plan.

Sitzmann, Vince. June 1996. Corydon Lake Water Quality Final Report, 1990-1995; Iowa Department of Agriculture and Land Stewardship.

Sitzmann, Vince. March 2000. Corydon Lake Water Quality Proposal; Iowa Department of Agriculture and Land Stewardship.

Sitzmann, Vince. April, 25 2000. E-mail on atrazine application rates in 1991 and 1999.

Sitzmann, Vince. April, 26 2000. Conversation record on atrazine application dates in 1999.

US Department of Agriculture. 1971. Soil Survey, Wayne County, Iowa.

* Indicates the sources were used in the input into the Screening Procedures Model.

12. Appendix I - Model Input

Constants and parameters used in the EPA Screening Procedures Model

All equations are taken from Water Quality Assessment: A screen procedure for toxic and conventional pollutants in surface and ground water- Parts I & II: EPA 600/6-85/002a &b, September 1985.

<u>Runoff</u> (pages152-156)

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

For $P \geq 0.25$

P= Precipitation, cm Used: Daily USGS data for water year 1991, and daily data received from IA Ag Dept for 1990-1993

S= Water retention
S=(2540/CN)-25.4 CN values can be found on page 155
Used: see table 1

<u>Pesticide</u> (Pages 190-207)

$$P_t = P_0 \exp(-k_S t) + \Delta P_t$$

$$Pt = P_t^+ \exp[-k_s 9t - t\,] + \Delta P_t$$

$$D_t = [1/(1 + K_D b / w)]P_t$$

$$A_t = [1/(1 = w / K_D b)]P_t$$

$$P_t^+ = P_t - PX_t - [1 - w / R_t]D_t$$

P_o= Amount of Pesticide applied (grams/ hectare) see Sitzman, 2000.
Used: see table 1

k_s = Decay rate (day^{-1})
Used: In Soil= **0.042** see Page 198
In Water= **0.01** see Grover, 1988

ô= addition of more pesticide or storm event on some day ô

w= available water capacity (cm/cm) values on page 195 (conservative value) Used**: 0.22**

b=Bulk density (g/cm^3) values on page 195 (based on soil types, conservative value) Used: **1.33**

K_D= pesticide partition coefficient (l/kg)
K_D**=** K_{OC} (%OC/100) value given on page 206 = **2.89**

<u>Conversion factors</u>

1 m^3 = 1000 l	1 lb = 453.6 g	1 acre = 0.4047 ha	1 ft^3 = 0.02832 $m^3$1
lb/acre = 1.121 kg/ha		1g = 1,000,000 ìg	1 inch = 2.54 cm